Appendix 4

Protocol Development Summaries for the First 18 Indicators Scheduled for Monitoring in SFAN
(Last Update 09/13/05)

Table of Contents

Protocol Development Summary

Weather and Climate

Parks where protocol will be implemented: EUON, GOGA, JOMU, PINN, PORE

Justification/Issues being addressed:
The Weather/Climate vital sign is ranked first among all of the potential vital signs evaluated by the SFAN. Knowledge about weather and climate is critical because they affect not just geophysical and biological resources but ecosystem drivers and processes. Key reasons for monitoring weather and climate in network parks are because the effects can be long-lasting on (1) plant and animal populations, some of which are listed as endangered or threatened species, (2) on air and water quality, and (3) on drought and flood cycles, fires, mass wasting and other catastrophic events. Long-term weather data can also contribute to the understanding of global climate change and its effects on Network ecosystems.
Nearly all of the Earth's biological activity occurs in the lowest part of the atmosphere. Since the meteorological conditions in this layer affect the chemical and biological processes taking place on the earth's surface, monitoring these conditions is important for environmental research. It is a major ecosystem driver, affecting all other ecosystem indicators in the SFAN conceptual model. Though our ability to "manage" weather and climate is limited (if not non-existent), it is an essential indicator for the long-term monitoring plan because its affects are short-term and long-term. An understanding of long-term climate trends and weather cycles is critical to understanding ecosystem processes and function.
This vital sign will eventually be linked with freshwater dynamics, air quality and oceanography for implementation and data evaluations.

Monitoring Questions to be addressed by the protocol:

1. How are climate and weather changing over time?
2. How do weather patterns vary across the network?
3. What are the maximum and minimum rainfall amounts in a given year?

Specific Monitoring objectives are:

- Determine variability and long-term trends in climate through monthly and annual summaries of selected weather parameters (termperature and precipitation).

- Identify and determine frequencies and patterns of extreme climatic conditions for common weather parameters.

Basic Approach:
The network currently operates 12 full weather stations and six individual rain gauges. Some are associated with a stream monitoring station. NPS weather stations will be downloaded on a monthly or bi-monthly basis with more frequent maintenance and calibration before winter storm events. Data will be managed in the SFAN weather database and reports will be created on a regular basis from this database. Other tasks include 1) completing a GIS coverage for all NPS and surrounding weather stations (within a 50 mile radius of the parks); 2) identifying procedures to upload data from NOAA and others and initiating processes for archiving data; and 3) coordinating with nearby government agencies to augment existing monitoring stations and data collection and management procedures. Given the longer time frame required to detect climate change, acquiring data from outside sources will help fill data gaps for climate modeling and correlating any changes in species diversity and population numbers to climate change.

Data analysis will vary from ten-year intervals to assess spatial-temporal changes related to climate change to daily or hourly data analysis for fire weather or storm rainfall totals (hydrologic analysis). Network staff will determine the feasibility of integrating flow and water level data with weather data. Rainfall patterns will be incorporated with stream hydrographs to aid in understanding storm recurrence intervals and watershed response.

Specific metrics may vary depending upon the park. All parks will monitor rainfall and temperature. Barometric pressure, wind speed/direction and relative humidity are not as vital of a need at some parks; however, these are critical components of a fire weather monitoring program.

Principal Investigators and NPS Lead:
I & M Aquatic Working Group: Darren Fong, GOGA Aquatic Ecologist (415-331-8716), Brannon Ketcham, PORE Hydrologist (415-464-5192) and Mike de Blasi, Network Physical Science Technician (415-331-0729).

Proposed Development Schedule, Budget, and Expected Interim Products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05 D	$20,000 (GS 7)	Complete draft protocol and SOP. Complete development of the weather database. Peer review protocol.
FY06 I	$21,000 (GS 7)	Revise protocols. Implementation of protocol at SFAN parks.
FY07 I	$22,000 (GS 7)	Implementation of protocol at SFAN parks.

D = Development
I = Implementation

Protocol Development Summary

Invasive Plant Species (early detection)

Parks where protocol will be implemented:
FOPO, JOMU, GOGA, MUWO, PINN, PORE, PRES

Justification/Issues being addressed:
Invasive plant species ranked second in the prioritized list of vital signs to be monitored for ecosystem changes and trends. Early detection of invasive plant species is a proven method for preventing the establishment of new species and limiting the spread of existing species into uninfested areas. This protocol provides information that can be used immediately by park managers to target new or expanding infestations. The data can also track long-term infestation patterns and potentially evaluate long-term effectiveness of invasive species management.

This protocol will build on and standardize efforts already in place in many parks including detection programs for finding invasive species with the assistance of park staff and volunteers. The protocol will outline methodologies that can be used as an opportunistic strategy with minimal staff in the field to a full volunteer/staff program with targeted and systematic efforts based on location, seasonality, ground-truthing and removal in appropriate instances. The protocol in development by SFAN will also be flexible in order to include future techniques and sampling strategies designed by USGS or other Networks working on early detection monitoring.

Monitoring questions to be addressed by the protocol:

1. Are new invasive plant species occurring in the parks?
2. Are populations of invasive plant species increasing in the parks?
3. Are invasive species spreading into sensitive or critical park habitat?
4. What are the main corridors for invasive species establishment?

Specific monitoring objectives for this indicator are:

- Develop and maintain a list of target species that do not currently occur in the parks, occur in localized areas of parks, or are extremely rare, but that would cause major ecological or economic problems if they were to become established.

- Detect new species and new populations of invasive species before they become established in areas of high and moderate management importance.

Basic Approach:
The first priority of early detection of invasive species will be to generate lists of potentially invasive species throughout the network. The second priority is to generate life history information (including phenologies) for priority species in order to identify potential pathways of invasion and sensitive habitats. In addition, efforts will be made to standardize data collection, data analysis, reporting, and archiving. The overall goal is to develop different levels of intensity in early detection monitoring so that each Network park can use what is appropriate given staffing levels, volunteer interests, and the need to prevent species from establishing in especially sensitive areas (e.g. areas likely to be invaded or areas with rare or endangered species). The protocols will include "passive" sampling by visitors, rangers, maintenance staff, and other field staff as well as standard operating procedures for a more intensive "directed sampling" effort using natural resource staff and trained volunteers.

Frequency:
Annually
Timing:
There is the potential for year-round sampling depending on focal species, availability of staff, outside funding and volunteer interest. The most effective time for detection depends on plant phenology, but is often February – July.

Principal Investigators and NPS Lead:
Andrea Williams, Natural Resource Specialist, 415-331-3679.

Proposed Development Schedule, Budget, and Expected Interim Products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05 D	$30,000 (GS 9 NR Specialist for 15 pay periods)	Standard Operating Procedures relating to volunteer-based and opportunistic sampling and data management for SFAN parks will be completed. The Network will work with Regional and National NPS Staff and USGS to share resources and components of an overall Early Detection Protocol.
FY06 D	$60,000 (GS 9 NR Specialist and GS 7 Biological Tech)	Test protocol and volunteer training procedures in GOGA. Complete data management components of protocol. Complete draft SOPs. Send SOPs out for review.
FY07 D/I	$65,000 (2-3 GS 7 Biological Techs)	Refine protocol. Implement early detection programs at GOGA, JOMU, PINN and PORE.

Protocol Development Summary

Freshwater Quality

Protocol: Freshwater Quality

Parks Where Protocol will be Implemented:
GOGA, JOMU, MUWO, PINN, PORE

Justification/Issues being addressed:
Freshwater Quality was ranked 3rd among all of the potential vital signs evaluated by the SFAN. The SFAN has many unique aquatic resources that are significant in an ecological and economic context. Freshwater systems within the network support a variety of threatened and endangered species including the California freshwater shrimp (*Syncharis pacifica*), coho salmon (*Oncorhynchus kisutch*), steelhead trout (*Oncorhynchus mykiss*), the California red-legged frog (*Rana aurora draytonii*), and Northwest Pond Turtle (*Clemmys marmorata mormorata*). Beneficial uses of freshwater bodies include contact recreation and non-contact recreation, fish spawning, agricultural water supply, and wildlife habitat. According to the San Francisco Bay Regional Water Quality Control Board, non-contact recreation includes activities like hiking and sightseeing; therefore, most streams within the parks must minimally meet the non-contact criteria for indicator bacteria. Freshwater quality also has direct impact on several other indicators including: Marine water quality, stream T&E species and fish assemblages, T&E amphibian and reptiles, riparian habitat, wetlands, and aquatic macroinvertebrates.

NPS also has a legal obligation to ensure streams meet minimum water quality standards. Through the Basin Plans the Regional Water Quality Control Boards (San Francisco Bay and Central Coast) have set numerical and narrative objectives for surface waters. There are specific numerical objectives for ammonia, pH, dissolved oxygen, and indicator bacteria listed by the Regional Water Quality Control Boards (San Francisco Bay and Central Coast; see protocol for details).
Since there are no national criteria for temperature, specific conductance, turbidity and Total Suspended Solids, individual parks will set goals based on what is known about natural ranges in these parameters or what criteria are currently under consideration.

Monitoring questions to be addressed by the protocol:

1. What are the existing chemical and biological ranges in water quality within SFAN streams?
2. What are the long-term trends in water quality in SFAN streams?
3. Is the water quality of SFAN streams in compliance with designated beneficial uses?
4. What are the point and non-point pollution sources within the watersheds?
5. Are specific management actions reducing pollution loads?

Specific monitoring objectives are:

- Determine variability and long term trends in water quality through monthly summaries of select parameters (temperature, pH, conductivity, dissolved oxygen, total nitrogen, nitrate, ammonia, flow, fecal and total coliforms), in priority freshwater sites.

- Determine the existing ranges and diurnal variability of water temperature, pH, conductivity, and dissolved oxygen at selected sites in priority streams within SFAN.

- Determine the extent that priority streams within SFAN meet federal and state water quality criteria for fecal indicator bacteria, un-ionized ammonia, dissolved oxygen, and pH through monthly sampling.

- Determine the annual, seasonal, and 30-day mean fecal coliform load to Tomales Bay (in impaired water body) from Olema Creek as required by the San Francisco Bay Regional Water Quality Control Board's Tomales Bay Pathogen TMDL Program.

Basic Approach

Freshwater sampling units will be watersheds or subwatersheds with specific sites chosen within a reach. SFAN watersheds have been identified in the *San Francisco Bay Area Network Preliminary Water Quality Status Report* (Cooprider, 2004). Specific waterbodies to be monitored will include Category 1 and Category 2 waterbodies as outlined by the Freshwater Work Group Subcommittee (NPS, 2002). Category 1 waters include Section 303d listed streams and significant water bodies (in the case of the SFAN, this would include Areas of Special Biological Significance (ASBS)). Category 2 water bodies are those that 1) have established threats, 2) are subject to ecological impairment, 3) are lacking baseline data or 4) are linked to another Vital Sign having water column measurement needs. It should be noted that all ASBS's within SFAN are coastal waters and would be covered in the future protocol for marine and estuarine water quality. It is important to note that channel type and hydrologic conditions do not play a significant factor in deciding on monitoring locations.

Additional criteria will be used to establish specific sites within these broad categories and to add water bodies of concern for individual parks that don't necessarily fall within Category 1 and 2. These additional criteria include: 1) evidence or suspicion of contamination at a particular site (e.g., faulty septic systems, agricultural use, pet waste, outfall pipe), 2) human or aquatic health issue (e.g., there is a swimming area in the receiving water of a stream, 3) presence of a stream gauge or other permanent hydrologic monitoring equipment (linkage to freshwater dynamics vital sign), and 4) linkage to other aquatic vital signs (e.g., stream fish assemblages). Co-locating water quality sites with past or current macroinvertebrate or fish monitoring sites helps ensure data linkages. Ideally all sites within a given watershed are sampled on the same day (or even around the same time) or during the same storm event. Sites should represent inputs from all

areas of the watershed (i.e., all major tributaries), capture the most downstream site within NPS property, and be permanent long-term sites (considering access). When choosing the number of sites within a watershed, we want to be as comprehensive as possible in representing the watershed while choosing a number of sites that is practical (considering laboratory and staff costs and logistics).

The Servicewide Inventory and Monitoring Program calls for required monitoring of all basic "Level 1" Water Quality Parameters. Required "Level 1" parameters include: flow, pH, specific conductance, dissolved oxygen, and temperature (NPS, 2002). A rapid bioassessment baseline and alkalinity are additional recommendations noted in other documents (NPS, 2003 and Irwin 2004). "Level 1" Case-By-Case Parameter Groups include: Toxic elements, clarity/turbidity, nitrate/nitrogen, phosphate/phosphorus, chlorophyll, sulfates, and bacteria.

Water quality sampling methods will primarily follow the *National Field Manual for the Collection of Water Quality Data* (USGS, 1998) but EPA methods will also be consulted. Sampling involves collection of water samples in laboratory-supplied containers appropriate for the parameter being measured; for streams, samples are taken from the center of the channel and middle of the water column where possible (for flowing waters, samples are not depth integrated). Basic water quality measurements are then taken using a multiparameter probe for dissolved oxygen, temperature, specific conductance, and salinity. A separate pH meter is used. A flow measurement is taken to complete the monitoring. Flows are measured using a Flo-Mate, pygmy, or Swoffer flow meter following USGS protocol (Rantz, 1982). Monitoring will be conducted monthly with some priority sites being monitoring during storm events.

Indicator bacteria are a primary concern for all SFAN parks. Fecal coliform samples are analyzed at an EPA approved laboratory using the SM 9221 Multiple Tube Technique (Most Probable Number) in "Standard Methods for the Examination of Water and Wastewater" (APHA-AWWA-WEF, 1998). Other techniques to be explored include the "Colilert" method for E.coli and coliforms using Quanti-tray 2000, IDEXX Laboratories, Inc.) This method is not yet approved by FDA for shellfish harvesting areas. The Tomales Bay Pathogen TMDL program requires fecal coliform analysis since the FDA shellfish standard is for fecal coliforms only (and Tomales Bay is a major commercial shellfish growing area). Since PORE monitors tributaries of Tomales Bay as part of the TMDL program, fecal coliforms must remain the primary indicator bacteria.

Total Suspended Solids (TSS) will be monitored and analyzed in the GOGA wet lab using standard methods (APHA, 1998). Analysis for suspended sediment concentration (SSC) will be considered as part of preliminary sediment TMDL monitoring on Olema Creek (using the existing turbidity threshold sampling unit). Laboratory equipment upgrades and additional staff time would be required to conduct SSC analysis required to meet USDA protocols (Redwood Sciences Laboratory, 2002) and USGS monitoring objectives for local (Tomales Bay Watershed) waters.

The extent of nutrient contamination in many SFAN parks is not yet clear. An analysis of

current baseline data as well as past data (see Stafford & Horne, 2004) indicated that nitrogen parameters were higher priority than phosphorus parameters. Ammonia, nitrate, and total kjeldahl nitrogen will be measured. Current baseline monitoring follows standard EPA protocols and includes ammonia and nitrate and all parks.

Macroinvertebrate sampling (for aquatic bioassessment) was completed in 2004 following the California Stream Bioassessment Protocol (Harrington & Born, 2003). Also see EPA EMAP (Environmental Monitoring and Assessment Program). Aquatic bioassessment was a lower priority on the SFAN indicator ranking list. Future sampling is uncertain at this time. Ideally,a rapid bioassesssment baseline would be obtained for all Category 1 and 2 streams and other priority areas (see above).

Principal Investigators and NPS Lead:
Protocol development will be completed by the SFAN Water Quality Specialist with guidance from NPS-WRD. Other guidance documents and protocols will be consulted including EPA, USGS, and Regional and local monitoring plans. NPS Lead: Mary Cooprider.

Proposed Development Schedule, Budget, and Expected Interim Products:
Protocol development will not require intensive research since protocols currently exist (e.g. EPA, USGS). SOPs will be developed for each water quality parameter and modified for individual parks as needed. SOPs are being developed through seasonal water quality monitoring initiated at all SFAN parks in winter 2004. This monitoring will work through the details of sampling locations and access and logistics (travel, timing, and transport to laboratories) for JOMU, GOGA, PINN, and PORE. These three seasonal sampling efforts will aid in reviewing analytical laboratory issues (QA/QC, scheduling, location, etc.) Sampling efforts will also aid in determining staff, training, and budget needs and operational requirements. Sampling design will be refined or re-written where necessary. Procedures for data analysis, handling, and reporting will also be developed.

YEAR	BUDGET	TASKS/PRODUCTS
FY05	$69,000	Complete draft protocol and SOP. Peer review of protocol.
FY06	$69,000	Implementation of protocol at SFAN parks. Meet with park staff. Provide guidance for management.
FY07	$69,000	Implementation of protocol at SFAN parks. Meet with park staff. Provide guidance for management.

D = Development
I = Implementation

References

American Public Health Association- American Water Works Association, Water Environment Federation. 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition.

Cooprider, M. 2004. San Francisco Area Network Preliminary Water Quality Status Report.

Irwin, R. 2004. Vital Signs Long-Term Aquatic Monitoring Projects:Part B Planning Process Steps: Issues to Consider And Then to Document In A Detailed Study Plan That Includes A Quality Assurance Project Plan (QAPP) And Monitoring "Protocols" (Including Standard Operating Procedures).

National Park Service. 2003. Baseline Water Quality Data Inventory and Analysis, Point Reyes National Seashore. Water Resources Division. Technical Report NPS/NRWRD/NRTR-2000/280.

National Park Service. 2002. Recommendations for Core Water Quality Monitoring Parameters and Other Key Elements of the NPS Vital Signs Program Water Quality Monitoring Component. Freshwater Workgroup Subcommittee. Fort Collins, CO.

Rantz, S.E. 1982. Measurement of discharge by conventional current-meter method. USGS WSP 2175.

Redwood Sciences Laboratory. 2002. Laboratory procedure for determining suspended sediment concentration. USDA Forest Service.

Stafford, S. and A. Horne. 2004. A review of the water quality monitoring programs in the National Parks in Central Coastal California. A report to the National Park Service. University of California, Berkeley. Dept. of Civil and Environmental Engineering.

U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A9, available online at http://pubs.water.usgs.gov/twri9A.

Protocol Development Summary

Air Quality

Parks where protocol will be implemented: GOGA, PINN, PORE,

Justification/Issues being addressed:
Air Quality was ranked fourth among all of the potential vital signs evaluated by the SFAN. Clean unpolluted air is essential for all life on earth. Air quality is linked to many natural processes, i.e. soil and water nutrients, photosynthesis, acidification of lakes and streams. PINN and PORE are rated as Class 1 areas by the Clean Air Act and are protected by strict air quality regulations. The rest of the parks in the SFAN are Class 2 areas and pollution regulations are less strict. However, in some instances federal land managers apply the "precautionary principle" and treat Class 2 areas with the same standards as Class 1 Areas.

Within NPS, a majority of parks show improvements in visibility on clear days and in the concentration of sulfates present in precipitation. Nearly all parks show degradation or no change in nitrate levels in precipitation. Almost half of the parks show significant degradation in ozone levels, with only few showing an improvement. Hazy conditions persist in most parks.

Monitoring questions to be addressed by the protocol:

1. Is there a measurable rate of change in air quality?
2. Do SFAN park meet visibility standards as they pertain to visibility impairment and human health.

Specific monitoring objectives are:

- Report on seasonal and annual status and trends of N and S concentration and deposition in precipitation at existing monitoring stations in SFAN parks.

- Report on seasonal and annual status and trends of fine particle concentrations and composition at existing monitoring stations in SFAN parks.

- Report on seasonal and annual status and trends of ozone concentrations in NCRN parks using metrics that are indicative of human health (e.g., 8-hour average) and plant response (e.g., SUM06).

Basic Approach:
The monitoring will mainly be implemented by the NPS Air Resource Division (ARD) and U.S. Environmental Protection Agency (EPA) using their monitoring protocols. The SFAN protocol will reflect the monitoring done by the parks and how data will be obtained and exchanged with ARD and EPA.

Frequency: Daily
Timing: Year-round

Principal Investigators and NPS Lead:
Judy Rocchio, PWR Physical Scientist – Air Resources (510 817-1431).

Proposed Development Schedule, Budget, and Expected Interim Products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05 I	$0	All monitoring is done by ARD using nationally approved standard protocols.
FY06 I	$0	Work with ARD to develop data transfer system for SFAN air quality data analysis.

D = Development
I = Implementation

Protocol Development Summary

Stream Fish Assemblages

Parks where protocol will be implemented: GOGA, JOMU, MUWO, PINN, PORE

Justification/Issues being addressed:
Stream Fish Assemblages (Salmonids) were ranked fifth among all of the potential vital signs evaluated by the SFAN. As an indicator of ecological health of freshwater stream systems, this vital sign category includes monitoring for a suite of species and conditions within stream aquatic habitat including habitat condition, fish assemblage, population, and community structure, as well as three threatened and endangered species: coho salmon (*Oncorhychus kisutch*); steelhead trout (*O. mykiss*); and the California freshwater shrimp (*Syncharis pacifica*).

The Stream Fish Assemblage vital sign includes monitoring for three threatened and endangered aquatic species. Coho salmon and steelhead are anadromous and the life stage requirements demand year-round, high-quality cold water, continuous riparian cover, and complex habitat and structure to accommodate development from egg to smolt stage. Monitoring of these species at multiple life stages is valuable to the understanding of aquatic conditions and a good measure of watershed health. Because coho salmon and steelhead live for more than a year in freshwater, and the conditions required to support them are highly restrictive, they are susceptible to anthropogenic impacts to the stream and riparian systems. Because salmonids are sensitive to watershed and habitat impacts, they are effective indicators of stream and aquatic health.

Monitoring questions to be addressed by the protocol:

1. What are the overall salmonid condition and trends within PORE, GOGA, and MUWO watersheds?
2. Are parks meeting resource protection mandates relative to salmonid habitat protection?
3. What habitat constraints exist in the parks that currently impede or limit salmon recovery efforts?
4. What are park salmonid population distribution and trends by watershed and year class?
5. Are the salmonid populations stable within the PORE, MUWO, and GOGA watersheds?
6. How do observed conditions and trends for SFAN salmonid populations compare with populations and trends for salmonids in other Central California Coast ESU watersheds?
7. What is the aquatic habitat and biotic response to restoration actions including fish passage, streambank stabilization, woody debris placement, riparian protection, etc.?
8. Where do non-native fish or invertebrates occur, and how do they affect native populations?
9. What are the fish populations and community assemblages within SFAN stream systems?

10. What is the distribution, condition, and health of non-salmonid fish assemblages within SFAN stream systems?
11. What is the annual variation in fish assemblage within the NPS section of Franklin Creek? Could riparian restoration activities enhance existing habitat?
12. At PINN, what is the distribution, extent, and assemblage of fish species within park streams? Is there a seasonal variation in use?

Specific monitoring objectives are:

- Determine long-term trends in size and age class distribution and production of salmonid smolts through spring trapping at select streams at PORE, MUWO, and GOGA.

- Determine long-term trends in timing and distribution of salmonid spawning, adult sex ratios, and escapement in select streams at PORE and GOGA.

- Track the distribution and relative abundance of California freshwater shrimp within known freshwater shrimp habitat in SFAN.

- Determine the trends in distribution, abundance, composition, and size/age structure of fishes at summer index reaches of SFAN streams of PORE, MUWO, and GOGA.

- Measure the long-term trends in distribution and assemblage of fish species through annual spring surveys of Chalone Creek at PINN.

- Measure the long-term trends in the annual fish assemblage, distribution and abundance through fish surveys within the NPS managed section of Franklin Creek at JOMU.

Basic Approach:
The protocol for this vital sign contains two distinct methods. One focuses on stream aquatic resources and another focuses on California Freshwater Shrimp. The protocol includes the overall narrative document and four stand-alone Standard Operating Procedure documents relating to the summer, winter, and spring monitoring protocols, as well as salmonid genetics sampling and handling procedures. An SOP for monitoring California freshwater shrimp is under development but would be compatible with regional monitoring methods (Serpa 1991; 2002).

Methods are divided into fine scale procedures for index reach sampling and broader basin-wide sampling.

Adult fish: Methodology used in these protocols has been used to estimate escapement for a variety of salmonids throughout the Pacific Northwest (Johnston et al. 1987; Irvine et al. 1992; Anderson and McGuire 1994).

Juvenile fish: index reach fish demographics with multiple pass electrofishing procedures (Bohlin et. al. 1989) and seining; basinwide juvenile fish production methods and analyses closely follow standard Hankin and Reeves two-stage sampling design (Doloff et. al 1993; Collins 2003).
Outmigrant smolt production: watershed smolt production will be assessed using methods developed and implemented in the north coast of California using pipe trap (Manning and Roelofs 1996) and fyke/pipe trap (Gallagher 2000; Barrineau and Gallagher 2001) methods.

Habitat condition: Index reach habitat surveys (woody debris, instream cover, habitat classification, substrate composition, and wetted channel dimensions) and Basinwide habitat surveys (habitat classification, substrate composition, and wetted channel dimensions) based on California Department of Fish and Game procedures (Flosi et. al. 1998);. Riparian habitat survey at select index stations using Coyote Creek Riparian Station procedures (Rigney et. al. 1996). Basinwide riparian habitat mapping based on aerial imagery (Grant 1988). Geomorphic surveys (profile and cross-section) for index stations (Harrelson et. al. 1994). Index reach photos.
One of the side benefits of this monitoring approach is that SFAN will be able to develop a population genetic structure and age-size relationship for salmonids through genetic sample collection and processing.

Frequency:
Annual for index station/every 5-10 yrs for basin
Timing:
Seasonal, based on life stage

Principal Investigators and NPS Lead:
Brannon Ketcham, PORE Hydrologist (415-464-5192) and Darren Fong, GOGA Aquatic Ecologist (415-331-8716).

Proposed Development Schedule, Budget, and Expected Interim Products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05 D,I	$56,000 (plus matching funds)	Complete peer review of protocol. Conduct monitoring at each site. Write annual report.
FY06 I	$59,000 (plus matching funds)	Implement program at SFAN parks. Write annual report.
FY07 I	$61,000	Implement program at SFAN parks. Write annual report.

D = Development
I = Implementation

Budget supports term technician at GS 7/4 level as well as minor support for annual travel between SFAN parks, equipment maintenance, and supplies. Matching funds for

FY 2005 and 2006 support two additional field technicians to conduct monitoring on salmonid streams.

Literature Cited

Anderson, D. and H. McGuire. 1994. Redwood Creek basin 1991-1992 spawning and carcass survey, annual report. Unpublished report. National Park Service, Redwood National Park. Arcata, CA.

Barrineau, C. E. and S. P. Gallagher. 2001. Noyo River fyke/pipe trap checking protocol. California State Department of Fish and Game. Steelhead Research and Monitoring Program, 1031 South Main, Suite A, Fort Bragg, California 95437. Report FB-07. 17 pp.

Bohlin, T., S. Hamrin, T.G. Heggberget, G. Rasmussen, and S.J. Saltveit. 1989. Electrofishing: theory and practice with special emphasis on salmonids. Hydrobiologia 173: 9-43.

Collins, Barry W. (editor). 2003. Interim restoration effectiveness and validation monitoring protocols, California Coastal Salmonid Restoration Monitoring and Evaluation Program. March 2003, p. 320. California Department of Fish and Game. http://www.dfg.ca.gov/nafwb/2003/200303_Interim_Protocol_Manual.pdf

Dollof, C.A., D.G. Hankin, and G.H. Reeves. 1993. Basinwide estimation of habitat and fish populations in streams. Gen. Tech. Rept. SE-83. USDA Forest Service Southeastern Forest Experiment Station, Asheville, NC. 25 pp.

Flosi, G., Downie, S., Hopelain, J., Bird, M., Coey, R. and Collins, B. 1998. California salmonid stream habitat restoration manual. 1998. 3rd ed. California Department of Fish and Game. 495 p. http://www.dfg.ca.gov/nafwb/pubs/manual3.pdf

Gallagher, S. P. 2000. Results of the 2000 Steelhead (*Oncorhynchus mykiss*) Fyke Trapping and Stream Resident Population Estimations and Predictions for the Noyo River, California with Comparison to Some Historic Information. California State Department of Fish and Game, Steelhead Research and Monitoring Program, Fort Bragg, CA. Report FB-03, September 2000. 75 pp.

Grant, Gordon. 1988. The RAPID technique: a new method for evaluating downstream effects of forest practices on riparian zones. Gen. Tech. Rep. PNW-GTR-220. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 36 p.

Harrelson, C.C., Rawlins, C.L. and Potyondy, J.P. 1994. Stream channel reference sites: an illustrated guide to field technique. Gen. Tech. Rep. RM-245. Fort Collins, CO. US Department of Agriculture, Forest Service. Rocky Mountain Forest and Range Experiment Station. 61 p.

Irvine, J. R., R. C. Bocking, and K. K. English, and M. Labelle. 1992. Estimating coho salmon (*Oncorhynchus kisutch*) escapements by conducting visual surveys in areas selected using stratified random and stratified index sampling designs. Canadian Journal of Fisheries and Aquatic Sciences 49: 1972-1981.

Johnston, N. T., J. R. Irvine, and C. J. Perrin. 1987. Instream indexing of coho salmon (*Oncorhynchus kisutch*) escapement in French Creek, British Columbia. Canadian Technical Report of Fisheries and Aquatic, No. 1573.

Manning, D.J., and Roelofs, T.D. 1996. Coho Carrying Capacity and Limiting Habitats Analysis – 1996 Smolt Trapping Protocol. Department of Fisheries, Humboldt State University.

Rigney, M., Fischer, C., and Sawyer, E. 1996. Riparian Station - How to Manual. Coyote Creek Riparian Station. San Francisco Estuary Institute. 104 p.

Serpa, L. 1991. California Freshwater Shrimp (*Syncaris pacifica*). Survey for the U.S. Fish & Wildlife Service, 44pp.

Serpa, Larry. 2002. 2000 Survey of the California freshwater shrimp, *Syncaris pacifica,* in Lagunitas Creek, Marin County, CA. Prepared for Marin Municipal Water District. January 26, 2000. 19pp.

Appendix 4: Protocol Development Summaries

Protocol Development Summary

Rare Plant Species

Parks where protocol will be implemented:
GOGA, PORE, PRES (PINN in later years)

Justification/Issues being addressed:
Invasive plant species ranked 6th in the prioritized list of vital signs to be monitored for ecosystem changes and trends. The San Francisco Bay Area Network (SFAN) appointed a working group to develop the vegetation related indicators and protocols. PORE and GOGA have spent several years conducting inventories and censusing of their numerous rare plant populations. PORE has over 50 plant species with federal, state or local status. GOGA has over 35 plant species, including those at PRES, with federal, state or local status. The inventory for PINN needs to be refined and better documented, but there is currently evidence for over 10 species.

In the summer of 2004, a ranking system was developed to help the parks determine which species are the "most rare" within SFAN park boundaries regardless of official listing status. The matrix was tested using the PORE inventory of rare plants. Another version of the ranking matrix will be used to determine which species are the most appropriate for long-term monitoring for trends and ecosystem health. This vital sign is one in which we are striving for a true systems approach while also taking into account the management needs of the parks. This vital sign is also part of a hierarchy of vegetation monitoring developed by the working group in which some rare species will be monitored via the plant community change protocols. Rare plant occurrences will be a component of the ranking matrix for determining which plant communities should be monitored. Species with inappropriate life history or location to be monitored via plant community, but are ranked very high in the rare plant monitoring matrix, will be considered for population monitoring. Rare plant monitoring data will be used with relevant wildlife and other vital signs monitoring, such as T&E butterflies and invasive species, for assisting with trend detection and causal relationships in overall vital signs monitoring program.

Monitoring questions to be addressed by the protocol:

1. How are rare plant populations changing in terms of distribution, abundance and condition within Network parks?
2. Are invasive species infestations correlated to rare plant population decline?
3. Are management actions causing changes (positive or negative) in rare plant populations?

Specific monitoring objectives are:

- Develop and maintain a list of target rare species based on a regional rarity matrix and in order to prioritize RTE monitoring efforts.

- Determine long-term trends of population abundance by conducting species specific surveys as needed of mapped populations.

- Identify potential threats (e.g. visitor trampling, presence and encroachment of invasive plant species, pest infestation), and estimate degree of threat to rare species at mapped locations in order to identify management needs.

- Monitor suitable habitats every 5-10 years in order to identify presence/absence of target species and incorporate them into annual abundance estimates.

Basic Approach:
The rare plant monitoring will actually be comprised of several different protocols. Currently, PORE has draft protocol in various stages of development for 3 of the 4 federally listed species. Those species which rank high in the rarity matrix and are known to be inappropriate for monitoring via plant community protocols based on population size and habitat preference (*Alopecurus aequalis* and *Chorizanthe valida*) will go forward with population level I & M protocol development based on past work. All other species, including those at GOGA and PINN, will go through a rigorous ranking process in collaboration with the plant community monitoring program. Future work will focus on developing appropriate monitoring protocols for those species that rank high but will not be captured via plant community monitoring. The field crews and protocol development work will be linked for the two indicators and create a streamlined approach to vegetation monitoring within SFAN.

Frequency:
Annually to intermittent depending on species.
Timing:
To be determined by monitoring protocol.

Principal Investigators and NPS Lead:
Andrea Williams, Natural Resource Specialist, 415-331-3679.

Proposed Development Schedule, Budget, and Expected Interim Products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05 D	$10,000	Field test methods for two endangered species at PORE. Bring existing protocol up to I & M standards in preparation for peer review. Run GOGA species through rare plant ranking matrices.
FY06 D	$15,000	Work with Plant Community team to incorporate rare plants into ranking matrix and determine suites of species to monitor. Continue developing protocols for PORE and GOGA species. Transfer PORE rare plant inventory database to new I & M design that can incorporate long-term monitoring data.

FY07 D & I	$25,000	Peer review protocols for PORE species. Implement monitoring of accepted protocols. Continue developing protocols for GOGA species (and PINN species as appropriate).

D = Development
I = Implementation

Appendix 4: Protocol Development Summaries

Protocol Development Summary

Northern Spotted Owl

Parks where protocol will be implemented: GOGA, MUWO, PORE

Justification/Issues being addressed:
Northern Spotted Owl was ranked seventh among all of the potential vital signs evaluated by the SFAN The federally threatened status of this species requires the NPS monitor the long-term status and trends of the population and maintain stable or increasing populations of spotted owls. This monitoring program provides the data required to accurately assess the status and trend of this isolated, potentially vulnerable spotted owl population, where it occupies a land use matrix strikingly different from that found throughout most of the owl's range. Our monitoring program contributes to the Northwest Forest Plan in working to arrest the downward trend in spotted owl populations and to maintain and restore the habitat conditions necessary to support viable populations of the northern spotted owl on federally administered forest lands throughout the range of the owl. The program has an eight-year history of monitoring spotted owls in the SFAN parks, which contributes to region and range-wide monitoring programs and park management activities.

Monitoring questions to be addressed by the protocol:

1. What is the trend in rates of reproduction and activity site occupancy of Northern spotted owls on federal lands in Marin County?
2. What is the abundance and distribution of Barred owls relative to Northern spotted owls?
3. Do changes in spotted owl population and reproductive success correlate with changes in weather and climate patterns?
4. Are changes in nest site selection corresponding to potential threats such as an influx of barred owls?

Specific monitoring objectives are:

- Monitor changes in spotted owl abundance and reproductive success at known owl activity sites within the NPS legislated boundaries of Marin County, California.

- Determine the long-term changes of nest site characteristics (e.g. tree species selected for nest sites, vegetation community selected for nest sites) at Northern Spotted Owl at known activity sites in order to evaluate habitat selection.

- Monitor suitable habitats every 5-10 years in order to identify population expansion of target species and incorporate them into annual abundance estimates.

Basic Approach:
US Forest Service Protocol (Forsman 1995) modified for Marin County (Fehring et al 2000). Annual monitoring of historic activity centers to determine occupancy, pair identification (bands) and reproductive status.

Frequency:
Yearly

Timing:
During breeding season (Mar - Aug)

Principal Investigators and NPS Lead:
Dawn Adams, PORE Ecologist (415-464-5202) and Bill Merkle, GOGA Wildlife Biologist (415-331-2894).

Proposed Development Schedule, Budget, and Expected Interim Products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05 I	$ 35,000 (GS 7 13PP)	Monitor according to protocol. Revise database to I&M standards. Provide next FY work plan. Complete annual report.
FY06 I	$37,000 (GS 7 13PP)	Implement full monitoring program. Provide next FY work plan. Complete annual report.
FY07 I	$39,000 (GS 7 13PP)	Implement full monitoring program. Provide next FY work plan. Complete annual report.

D = Development
I = Implementation

Monitoring will be partially supported by PRBO Conservation Science, Marin Municipal Water District and Marin County Open Space District.

Literature Cited:
Fehring, K.E., D. Hatch and D.B.Adams. 2000. Modified protocols for spotted owl monitoring and demographic studies in Marin County, California.

Forsman, E.D. 1995. Appendix A: Standardized protocols for gathering data on occupancy and reproduction in spotted owl demographic studies. Pp. 32 – 38 *IN* J. Lint, B. et.al. 1999. Northern Spotted Owl effectiveness monitoring plan for the Northwest Forest Plan. U.S. Forest Service Gen.Tech. Rep. PNW-GTR-440.

Protocol Development Summary

Amphibians and Reptiles

Parks where protocol will be implemented: PORE, GOGA, PINN, JOMU, MUWO, PRES

Justification/Issues being addressed:
Amphibian and reptile populations ranked eighth out of all potential vital signs in the San Francisco Bay Area Network (SFAN). The protected legal status of two these taxa (San Francisco garter snake and red-legged frogs) require the NPS to evaluate the condition of these populations. Due to their habitat and physiology, these taxa are particularly sensitive to environmental degradation, such as air and water pollution. Because they are mid-level predators, population trends in these taxa may indicate trends in populations of animals at both higher and lower trophic levels. Standard protocols are available for sampling these animals in the San Francisco Bay Area, in some cases long-term monitoring data sets already exist.

In addition to monitoring the two federally-protected herptile species found in the network, the protocol will also address monitoring of terrestrial amphibian and reptile assemblages.

Monitoring questions to be addressed by the protocol:

1. What are the long-term trends of these populations/assemblages?
2. What is the natural variability in the population levels/diversity of these species/assemblages?
3. What are the breeding and non-breeding habitats for the special status species? How are these habitats changing over time? How are they changing relative to regional changes in hydrologic regimes?
4. Where in the SFAN parks are these species/assemblages found? Are populations/assemblages relatively stable or transient?

Specific monitoring objectives are still being determined. Potential monitoring objectives are:

- Determine variability and long-term trends in amphibian and reptile assemblages in key terrestrial habitats.

- Determine relative abundance of populations of key threatened and endangered amphibians and reptiles, such as California red-legged frogs (*Rana aurora draytonii*) and the San Francisco garter snake (*Thamnophis sirtatlis tetrataenia*) within the network parks.

- Determine distribution of populations of key threatened and endangered amphibians and reptiles within the network parks.

- Monitor habitat variables at breeding sites for the key threatened and endangered species.

Basic approach:
Monitoring will be divided into three efforts: monitoring of the California red-legged frog, monitoring of the San Francisco garter snake, and monitoring of terrestrial amphibians and reptiles.

Detailed protocols for monitoring California red-legged frog (RLF) have been developed at PORE and GOGA by U.S. Geological Survey (USGS) Biological Resources Division Scientist Gary Fellers. Existing data regarding this species includes demography and population counts at selected breeding ponds in PORE and GOGA, stream presence/absence of adults and egg mass surveys at PINN, and stock pond adult and egg mass presence/absence surveys at PORE. The protocols also include qualitative monitoring of habitat conditions. The existing protocols will be adapted to conduct breeding pond surveys at selected sites at PORE, GOGA, and PINN. In addition, existing stream surveys at PINN will be expanded to include streams at PORE and GOGA, in order to obtain information about the condition of stream-breeding RLF across a latitudinal range.

Protocols do not exist for monitoring the San Francisco garter snake (SFGS) on park lands. Monitoring this species will be difficult, as the snakes are extremely rare and well dispersed. However, SFGS range is limited to one 80-acre site within GOGA. Monitoring techniques may include visual encounter surveys along walked transects, mapping of locations where animals are encountered, habitat type and condition assessment, and pit traps.

Inventories of terrestrial amphibians and reptiles have been conducted for PORE, the northern unit of GOGA, and PINN using coverboards and pit traps. These inventory methods can be easily adapted for use in monitoring, with standard, well-accepted protocols. Unfortunately, these methods predominantly catch abundant/susceptible species, such as slender salamanders, alligator lizards, and ensatina salamanders. Coverboards and pit traps are less successful at detecting rare or secretive species. The methods are not useful for estimating species richness or diversity, or for calculating population sizes. However, these methods provide a quantitative measure of population trends among common terrestrial herptiles, are relatively inexpensive, and minimize observer bias.

Principal investigator and NPS lead:
Protocol development will be conducted by the NPS Pacific West Region Aquatic Ecologist, Marie Denn (415-464-5222), with collaboration from the USGS Western Ecological Research Center Senior Scientist Gary Fellers (415-464-5185), GOGA Aquatic Ecologist, Darren Fong (415-331-8716), and PINN Herpetologist Paul Johnson (831-389-4485, x270). Potential Principal Investigators: Gary Fellers, Darren Fong, Paul Johnson, Marie Denn. NPS Lead: Marie Denn

Proposed Development schedule, budget, and expected interim products:
Due to previous work on amphibians and reptiles in SFAN parks, additional inventories are not recommended. During FY05 a workshop will take place to discuss the current status of amphibians and reptiles and determine the best methods for long-term monitoring. The workshop will include NPS staff, USGS staff and academics with background in amphibian and reptile population monitoring. Long term costs for monitoring herptile taxa are unknown at present: vehicles for conducting monitoring will be direct-hiring of NPS personnel and contracts with USGS personnel.

YEAR	BUDGET	TASKS/PRODUCTS
FY05	$4,000	Compile potential monitoring methods to address draft monitoring questions. Conduct workshop to refine monitoring questions, refine baseline data compilation, discuss relative merits of monitoring methods, select potential monitoring sites
D1 (not yet scheduled)	$15,000	Conduct field tests of monitoring methods. Analyze pilot data to determine final monitoring methods, site placement, monitoring frequency, detailed analysis methods. Complete draft monitoring protocol
D2 (not yet scheduled)	$30,000	Implement pilot program to test monitoring protocols. Analyze pilot data to further refine draft protocol. Submit draft protocol for peer-review.
I (not yet scheduled)	$24,000 (GS5 seasonal)	Implement final protocol.

D = Development
I = Implementation

This protocol is currently unfunded in FY06 and FY07. Protocol development and implementation will come on-line as other indicators are cycled off for funding and outside funding sources are utilized.

Literature Cited:

Fellers, G. and K.L.Freel. 1995. A Standardized Protocol for Surveying Aquatic Amphibians. National Park Service Tech.Rpt. NPS/WRUC/NRTR-95-01 and Univ.of California Tech.Rpt. UC-CPSU-TR-#58.

Fesnock, A.L. and P.G. Johnson II. 2002. Reestablishing California Red-Legged Frogs to their Historical Range Within Pinnacles National Monument. Wildlife Society, paper presented at Western Section Meeting, March 7-9, 2002, Visalia, CA.

Appendix 4: Protocol Development Summaries

Protocol Development Summary

Western Snowy Plover

Parks where protocol will be implemented: GOGA, PORE, PRES

Justification/Issues being addressed:
Western Snowy Plover (*Charadrius alexandrinus nivosus*) ranked ninth out of all potential vital signs in the San Francisco Bay Area Network (SFAN). The federally threatened status of this species requires the NPS to monitor the long-term status and trends of the population and maintain stable or increasing populations of Western Snowy Plovers. Western snowy plovers are listed as federally threatened species and under the Endangered Species Act. They are also part of the coastal dune ecosystem, which is identified as an important habitat for conservation in the PORE enabling legislation. Western snowy plovers are good indicators of the condition of the coastal dunes ecosystem and are the only nesting shorebird in the coastal habitats. There is a 20-year history of monitoring snowy plovers at PORE and GOGA.

Monitoring questions to be addressed by the protocol:

1. What is the Western snowy plover population size at PORE and GOGA during the breeding and wintering season?
2. What are the short-term (<5 years) and long-term trends for the population size?
3. Do breeding locations change annually?
4. What is the annual fecundity (i.e. number of fledged young per male)?
5. Are human or management activities (i.e. dune restoration) affecting plover breeding sites or plover wintering activities?
6. What are the causes of mortality of eggs, young, and adults?

Specific monitoring objectives are:

- Determine long-term changes in the breeding population size, distribution, and reproductive success of snowy plovers at known breeding beaches at PORE.

- Determine changes in wintering population size and distribution of snowy plovers at known wintering beaches at GOGA and PORE.

- Determine trends in pollutant loads (e.g. mercury and selenium) in plover eggs, chicks, and adults, as funds are available in order to evaluate potential hazards.

- Monitor suitable habitats every 5-10 years in order to identify population expansion of target species and incorporate them into annual abundance estimates.

Basic Approach:
Beach censuses will be conducted at GOGA and PORE during winter season and PORE

during breeding season (March - Sept). At PORE during breeding season: nest searching (#eggs, #chicks), adult population estimates, nest location mapping, and predator surveys. Follow chicks to determine fledging rate. Protocol was developed by PRBO.

Frequency:

Yearly

Timing:

Breeding season at PORE, winter season at both

Principal Investigators and NPS Lead:

Dawn Adams, PORE Ecologist (415-464-5202) and Bill Merkle, GOGA Wildlife Biologist (415-331-2894).

Proposed Development schedule, budget, and expected interim products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05 D	$0	Revise database to I & M standards. Park wildlife biologists will work on developing draft protocols for GOGA. Submit PORE protocol for peer-review.
FY06 D	$5,000 (GS-6 1PP)	Train GOGA volunteers and write annual report. Develop work plan for FY07. Peer review GOGA protocol.
FY07 D & I	$20,000	Conduct surveys with volunteers at GOGA. Implement monitoring at PORE. Write annual report Develop work plan for next FY.

D = Development

I = Implementation

Protocol Development Summary

Pinnipeds

Parks where protocol will be implemented: GOGA, PORE, PRES

Justification/Issues being addressed:
Pinnipeds rank tenth out of all potential vital signs in the San Francisco Bay Area Network (SFAN). Pinnipeds come under the legal mandates of the Endangered Species Act and Marine Mammal Protection Act. They are also specifically identified in the enabling legislation of and management objectives of PORE. Pinnipeds are good indicators of the condition of the marine ecosystem because they respond quickly to oceanic conditions and food resources. There is a long history of monitoring pinnipeds at PORE and GOGA in collaboration with other agencies and organizations. Changes in pinniped population size, distribution and reproductive success can provide an early warning of abnormal conditions and impairment of the marine ecosystem. Identifying natural and anthropogenic threats and quantifying the level of disturbance to harbor seals will also be critical in order to effectively manage and protect pinnipeds.

Monitoring questions to be addressed by the protocol:

1. What are the status and trends of the pinniped population sizes and distribution.
2. What is the natural level of variation in the pinniped population size and reproductive success?
3. Are elephant seals and harbor seals reproducing successfully?
4. How do natural and anthropogenic disturbances affect seal haul-out use and productivity?

Specific monitoring objectives are:

- Determine long-term trends in annual population size and annual and seasonal distribution of pinniped populations at PORE and GOGA.

- Determine long-term trends in reproductive success of elephant seals and harbor seals populations through annual estimates of productivity at PORE and GOGA.

- Identify potential threats (i.e. presence of hikers, motor boats, or airplanes presence), and estimate degree of threat at harbor seal haul outs in order to identify management needs.

Basic Approach:
Weekly surveys of sites during breeding seasons (elephant seal, harbor seal). Bi-monthly surveys at Point Reyes Headlands of all pinniped species year-round. The protocol is currently undergoing peer-review.

Frequency:
Annual
Timing:
Breeding seasons, year round

Principal Investigators and NPS Lead:
Dr. Sarah Allen, PORE Senior Scientist (415-464-5187), and Dawn Adams, PORE Ecologist (415-464-5202).

Proposed Development Schedule, Budget, and Expected Interim Products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05 I	$18,000	Test and revise protocols. Revise database to I & M standards. Complete summary report and next FY work plan.
FY06 I	$30,000	Implement protocols. Train volunteers. Complete summary report and next FY work plan.
FY07 I	$22,000	Implement protocols. Train volunteers. Complete summary report and next FY work plan.

D = Development
I = Implementation

Protocol Development Summary

Plant Community Change

Parks where protocol will be implemented:

FOPO, JOMU, GOGA, MUWO, PINN, PORE, PRES

Justification/Issues being addressed:

Numerous biotic and abiotic factors have altered and continue to threaten plant communities within SFAN. As plant communities continue to recover from past resource extraction and grazing, there is a need to understand how current activities are effecting this recovery. It is also important to monitor and evaluate changes to the composition of plant communities and type changes occurring on the landscape. The monitoring program proposed assimilates multiple vital signs including invasive plant species, threatened and endangered plant species, wetlands, grassland plant communities, oak woodlands, and plant species at the edge of their range. There are also significant ties between plant community change and almost all of the faunal indicators being monitored such as landbirds, Northern spotted owls, endangered butterflies, etc.

Monitoring questions to be addressed by the protocol:

1. Are there changes in abundance of rare native species within selected plant communities?
2. Are there changes in abundance of the dominant, co-dominant and indicator species that are important components of the structure and function of the selected plant communities?
3. Are there trends in diversity metrics (native & non-native) at the plot and community level?
4. Are the long-term effects of management activities such as prescribed fire, grazing, restoration, and trail/road maintenance changing the plant communities?

Specific monitoring objectives are:

- Develop and maintain a list of priority plant communities based on their rarity and degree of protection.

- Detect long-term trends in native and non-native abundance and distribution within selected plant communities.

- Detect changes in overall vegetation cover, vegetation type and species composition of selected SFAN plant communities through monitoring every 7-10 years.

Basic Approach:

1. Create a sampling design for a network of permanent and randomized plots and/or transects that efficiently detect and monitor changes in the composition and

structure of selected plant communities throughout San Francisco Area Inventory and Monitoring Network of Parks.
2. Establish a subset of the sampling scheme created above and collect vegetation data as a pilot study.
3. Design the plant community sampling scheme to capture several of the highly ranked broad vegetation related indicators.
4. Design the plant community monitoring program to detect changes in abundance (at specified levels and power) for rare and non-native invasive species that are targeted to monitor at the community level.
5. Complete plant community classifications for all SFAN parks.

Principal Investigators and NPS Lead:
Andrea Williams, Natural Resource Specialist, 415-331-3679.

Proposed Development Schedule, Budget, and Expected Interim Products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05	$0	Data gathered for rare plant matrices will assist in later ranking of vegetation communities for long-term monitoring.
FY06	$ 11,000	Complete ordination analysis of existing plot data for PORE-GOGA. Identify new plant communities. Update plant community key and descriptions. Run Urban (2001) model for site selection for plant community monitoring for PORE-GOGA. Create and run (ranking matrix) to identify plant communities for monitoring at PORE-GOGA
D1	?	Analyze existing plot data on the selected communities for PORE and GOGA to assist with determine sampling size and geographic distribution required for desired level of change detection. Install pilot plots in the selected plant communities and collect reference data.
D2	?	Complete power analysis of plot data. Write protocols for the selected plant communities at PORE-GOGA. Send off for peer review. Review ordination analysis and existing plot data and existing vegetation monitoring programs at PINN. Run Urban model for site selection.
D3	?	Write draft monitoring protocols for PINN, JOMU. Peer review.

		Complete plot installation and revisits for PINN, JOMU. Install / reread pilot plots in the selected plant communities for all parks and collect reference data.
D/I	?	Incorporate peer review comments for all protocols. Finalize detailed SOPs. Write final report with metrics for all plant communities selected for monitoring. Install / reread pilot plots in the selected plant communities for all parks and collect reference data.

D = Development
I = Implementation

Appendix 4: Protocol Development Summaries

Protocol Development Summary

Landscape Dynamics

Parks where protocol will be implemented: EUON, FOPO, JOMU, GOGA, MUWO, PINN, PORE, PRES

Justification/Issues being addressed:
Regional landscape & land use change (Landscape Dynamics) was ranked 12th among all of the potential vital signs evaluated by the SFAN. Key reasons for monitoring regional landscape & land use change are (1) the rapid development of neighboring lands (2) the fragmentation of wildlife habitat (3) the need to detect life-form change within parks, and (4) to provide early warning of large-scale community shifts.

Monitoring questions to be addressed by the protocol:

1. What is the baseline resource condition (landform habitat type)
2. Are the landforms changing?
3. Do the landform processes affect change on a natural scale?
4. How has wetland type, structure, and extent changed?
5. To what extent has development caused habitat fragmentation?
6. How are wildlife corridors changing?
7. How connected are the parks to neighboring open spaces
8. What are the effects of land use change within the region?
9. What is the effect of global climate change on a landscape level?
10. What is the status of wildlife corridors within the I & M Network?

The monitoring objectives are:

- Determine status and trends in the areal extent and configuration of land-cover types (Anderson Level II) on park lands in order to evaluate large scale changes affecting park resources.

- Determine status and trends of key landscape metrics (e.g. proportion of area in different cover types, number and density of patches, mean patch size) of park lands and a ½ mile buffer in order to determine land use patterns in the parks.

Basic Approach:
Monitoring landscape dynamics would use two basic approaches. The first approach would focus on using a restrospective analysis in order to evaluate historic changes of landscape patterns and conditions. The second would focus on current through future conditions by obtaining current satellite imagery. Minimum resolution of imagery used would be comparable to Landsat or IKONOS.

Available information concerning landuse/landscape change work already being conducted in the Bay area would be gathered prior to initiating any new work. All

historic interpretation would be conducted as funding became available. Analysis of wetlands would include change in type, structure, and extent.

Frequency:
Every 10 years analysis would be conducted for all network parks
Timing:
Seasonality of images would be selected to maximize identification of major community types.

Principal Investigators and NPS Lead:
Dave Schirokauer, PORE GIS Biologist (415-464-5199).

Proposed Development schedule, budget, and expected interim products:
Development of protocol would be closely linked to development of national protocol. Actual personnel could be a combination of NPS and CESU employees.

YEAR	BUDGET	TASKS/PRODUCTS
FY05	$0	Coordinate with the National program to determine the most current and accepted methods.
D1	?	Work with National, regional and other Networks to develop SFAN protocols.
D2	?	Test protocols using pilot studies at SFAN. Revise protocols as needed.
D3/I	?	Peer review protocols. Implement program

D = Development
I = Implementation

This indicator is not currently funded in the FY05-FY07 draft budget.

Protocol Development Summary

Threatened and Endangered (T & E) Butterflies

Parks where protocol will be implemented: GOGA, PORE

Justification/Issues being addressed:
Threatened and Endangered (T & E) Butterflies were ranked 13th among all of the potential vital signs evaluated by the SFAN. The protected legal status of these taxa require the NPS to evaluate the condition of these populations. Because they are closely tied to host and nectar plants, butterfly populations are good indicators of the general health of habitat. These taxa have very specific habitat requirements during different developmental stages, including specific host and nectar plants.

Monitoring questions to be addressed by the protocol:

1. Are the distributions or abundances of T&E butterflies changing?
2. Are the conditions and/or distribution of butterfly habitats changing?

Specific monitoring objectives are:

- Determine the trends in population distribution and abundance of threatened and endangered butterflies within known habitats in GOGA and PORE.

- Detect changes in acreage of habitat available for butterfly populations at GOGA and PORE such that potential impacts on the butterfly populations may be identified.

- Predict and identify new lupine habitat annually in order to identify new butterfly populations.

Basic Approach:
Mission blue butterfly (MBB): permanent and random butterfly transects during adult flight season, vegetation monitoring of their larval host plants and nectar sources.

Myrtle's silverspot butterfly (MSB): permanent and random butterfly transects during adult flight season, larval host plant monitoring (both done every two years).

Frequency:
Annual for MBB, biannual for MSB
Timing:
Flight seasons (spring for MBB, summer for MSB)

Principal Investigators and NPS Lead:
Dawn Adams, PORE Ecologist (415-464-5202) and Bill Merkle, GOGA Wildlife Ecologist (415-331-2894).

Proposed Development Schedule, Budget, and Expected Interim Products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05 D	$0	Test existing park protocols for Mission blue butterflies. Begin developing draft protocols to meet I & M standards.
FY06 D	$0	Peer review Mission blue butterfly protocol.
FY07 I & D	$6,000	Refine Mission blue butterfly protocol. Implement at GOGA Write draft protocols for Myrtle silverspot butterfly at PORE.

D = Development
I = Implementation

Protocol Development Summary

Freshwater Dynamics

Parks where protocol will be implemented: GOGA, JOMU, PINN, PORE

Justification/Issues being addressed:
Freshwater Dynamics is ranked 14th among all of the potential vital signs evaluated by the SFAN. Streamflow characteristics offer some of the most appropriate and useful indicators for assessing river ecosystem integrity over time. The hydrologic output of a watershed is a function of the land characteristics and human use, the weather and climate conditions, urbanization and soil characteristics. Hydrologic variation plays a key part in structuring the biotic diversity within river ecosystems by controlling critical habitat conditions within the river channel, the floodplain, and hyporrheic zones. Stream hydrology data provides key "support" data for vital signs indicators including stream T&E species and fish assemblages, T&E amphibians and reptiles, wetlands, and riparian habitat.

Monitoring questions to be addressed by the protocol:

1. How has development changed streamflow dynamics?
2. What are the long-term hydrologic trends for stream flow and water level?
3. How does the climate and weather affect the hydrology on parklands?
4. Are changes in water levels within a natural range of variation?
5. What are flood recurrence levels?

Specific monitoring objectives are:

- Monitor the variability and long-term trends in stream flow based on monthly and storm event-related discharge measurements at fixed stations in GOGA, JOMU, MUWO, PINN, and PORE.

- Monitor the frequency, magnitude and duration of peak flow events at fixed water level monitoring stations by producing instantaneous peak, hourly, daily, monthly and annual summaries of stage height and discharge in GOGA, JOMU, MUWO, and PORE.

- Monitor the frequency, magnitude and duration of unnatural or extreme low water/low flow events in stream reaches known to support threatened and endangered aquatic species in the dry season at GOGA and PORE.

Basic Approach:
Currently there are five automated stream gauging stations within SFAN (1 at JOMU, 2 at GOGA, and 2 at PORE). There is a proposal to install a fixed crest gauge and staff plate at PINN. Primary monitoring tasks include obtaining stream flows; developing hydrographs and other data analysis tools for each stream gauge; downloading,

maintaining, and calibrating hydrologic stations; and refining the methodology for these tasks. Duties also include conducting literature reviews on monitoring parameters, instrumentation, and protocols for hydrologic monitoring. Recommendations for equipment replacement, upgrade, and installation will be made on a regular basis.

Flow measurements will be obtained monthly during the summer (in conjunction with station maintenance and downloading) and at regular intervals during winter storms to maintain the stage-discharge rating curve. Portable flow meters or current meters will be used to obtain discharge following the USGS standard protocol (Rantz 1982). Water level monitors (pressure transducers) will be utilized as well at staff gauges or staff plates. Data collection and management will focus on the five automated stream gauging stations within the network. However, as the monitoring plan is implemented and streamlined there will be opportunities to include data from locations without automated stream gauges (e.g., staff plates at water quality monitoring sites and fish traps).

Informal surveys may be conducted in order to determine any water use. Local agencies may be contacted to obtain records of water use and/or water or well levels. Therefore, Freshwater Dynamics would become integrated with Groundwater Dynamics.

Principal Investigators and NPS Lead:
The SFAN Hydrologic Technician will complete protocol development. The aquatic working group will supervise and manage program. Darren Fong, GOGA Aquatic Ecologist (415-331-8716), Brannon Ketcham, PORE Hydrologist (415-464-5192).

Proposed Development schedule, budget, and expected interim products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05	$20,000 (GS 7)	Complete draft protocol and SOP. Standardize data collection and mgmt. Complete development of a stream gauge database. Peer review protocol.
FY06	$21,000 (GS 7)	Revise protocol. Implementation of protocol at SFAN parks.
FY07	$22,000 (GS 7)	Implementation of protocol at SFAN parks.

D = Development
I = Implementation

Literature Cited

Rantz, S.E. 1982. Measurement of discharge by conventional current meter method. U.S. Geological Survey WSP 2175.

Protocol Development Summary

Wetlands

Parks where protocol will be implemented: GOGA, JOMU, MUWO, PINN, PRES, PORE

Justification/Issues being addressed:
Wetland integrity ranked 15th out of all potential vital signs in the San Francisco Bay Area Network (SFAN). Wetlands are keystone ecosystems in the San Francisco Bay Area. Some ecologists call wetlands "the kidneys of the landscape" as they provide water quality protection, flood and drought mitigation, erosion control, and groundwater recharge functions. Wetlands have also been called "biological supermarkets," for supporting complex food webs, housing a rich biodiversity of wetland-endemic species, and providing habitat functions for many aquatic and terrestrial species. An estimated 46% of US endangered and threatened species and 50% of all bird species require wetland habitat. Wetland habitats are vulnerable to alteration due to global climate change and associated potential temperature, hydrology, and salinity regime changes. Understanding the condition of wetlands in SFAN parks may be a good proxy for understanding the condition of many taxa of concern in the network.

The San Francisco Bay Area Network includes estuarine, palustrine, lacustrine, and riverine wetlands. The two coastal parks in the network, PORE and GOGA contain a combined 120 miles of coastline, with numerous small estuarine wetlands at the convergence of freshwater streams and the Pacific. In addition, these parks contain and boarder on some of the most pristine (Drakes Estero) and largest (San Francisco Bay) estuaries on the west coast of North America. Palustrine wetlands are found within PORE, GOGA, PINN, PRES, and MUWO. These host rare and protected plants, and provide critical habitat for migratory birds. Natural lacustrine wetlands within the network are limited to several small ponds and lakes within GOGA and PORE, while riverine wetlands are found in all SFAN parks covered by this protocol.

Parks within the SFAN have made a concentrated effort to map and characterize wetlands on park lands using the Cowardin et al. (1979) classification. All of these mapped wetlands are classified by wetland type (i.e. palustrine, estuarine, riverine, lacustrine) and plant community (e.g. scrub-shrub, emergent). Many of the mapped wetland polygons are also characterized by dominant hydrology, function (e.g. flood retention, wildlife habitat), and major stressor (e.g. grazing, adjacent development, invasive species).

Monitoring questions to be addressed by the protocol:

1. How is the extent, type, condition, and function of wetlands changing over time in response to anthropogenic stressors and climactic variability. For example,
2. Is the hydrology of these wetlands changing over time in response to grazing, development, climate change?

3. Is the type of wetland changing over time, e.g. are emergent vegetation communities shifting to scrub-shrub communities?
4. Is native plant/animal use of SFAN wetlands changing over time?
5. Are invasive plant populations in SFAN wetlands increasing or decreasing?

The draft monitoring objective is:

- Determine if the extent, type, condition and function of wetlands is changing.

Basic approach:
The wetlands monitoring program will be built upon wetland inventories that have already been completed in SFAN parks. These inventories resulted in a map of wetland polygons. A set of polygons from this map will be selected for cyclic monitoring on a 'fixed site + rotating panel' design. The network acknowledges that selecting polygons only from existing wetlands maps will result in a non-random selection of wetland polygons within the network, as wetland mapping efforts have been unevenly distributed throughout SFAN lands.

Mapped wetland polygons will be stratified first by type (i.e. palustrine, estuarine, riverine, lacustrine), then by predominant stressor type (e.g. grazing, adjacent development, invasive species, no evident threat). Wetland polygons will be sampled from the resulting data set so that each major type is well represented. Samples will not be random, but may be chosen for accessibility and representativeness. Because wetlands in Wilderness portions of SFAN parks are not expected to change appreciably in the near- to mid-term time scale, cyclic monitoring will focus on wetlands that are subjected to known stressors. A set of wetland polygons with no known threats will be sampled, also, as the control.

These selected wetlands will be sampled quantitatively for integrity indicators such as water quality, water quantity, channel sinuosity and entrenchment, exotic plant cover, plant diversity, and percentage of obligate wetland plants. The specific vital signs to be measured at each wetland polygon have not been identified as yet. SFAN staff is working with an interagency group, based in the San Francisco Bay Area, which is currently developing a quantitative monitoring program for assessing wetland integrity and changes in this ecoregion. This protocol has high potential to form the foundation of a wetlands monitoring program for SFAN, the purpose of which will be to assess local-scale, rapid response of wetlands to management and land use change.

Principal investigator and NPS lead:
Protocol development will be coordinated by the NPS Pacific West Region Aquatic Ecologist, Marie Denn (415-464-5222) with collaboration from PORE GIS Biologist Dave Schirokauer (415-464-5199); PORE Wetlands Ecologist Lorraine Parsons (415-464-5193), and GOGA Aquatic Ecologist Darren Fong (415-464-8716). Principal Investigators: to be determined. NPS Lead: Marie Denn

Proposed Development schedule, budget, and expected interim products:
Development of a wetland monitoring protocol will take place in two phases: first, draft protocol development, and second, implementation of a pilot study, and refinement of the draft protocol prior to full implementation.

There is currently no funded allocated to this project in the draft FY05-FY07 budget.

Phase 1, Draft Protocol Development: Development of a draft protocol for SFAN parks is estimated to require 0.5 FTE of GS-9 Wetlands Ecologist/GIS Specialist for 12 months. This employee will compile existing data, stratify previously-mapped wetland data sets, and collaborate with interagency groups in the San Francisco Bay Area to adapt existing/in-development wetland monitoring protocols to SFAN parks. This staff person will require the use of a GIS-capable computer, and intermittent use of a park vehicle. *Interim products:* stratified map of previously-classified wetlands on SFAN lands, draft protocol for monitoring specific attributes of sampled wetlands (e.g. water quality, water quantity, channel sinuosity and entrenchment, exotic plant cover, plant diversity, percentage of obligate wetland plants).

Phase 2, Pilot Study and Protocol Finalization: Finalization of the protocol will require 0.75 FTE of GS-9 Wetlands Ecologist/GIS Specialist for 12 months, and 0.5 FTE of GS-5 Biological Science Technician for 12 months. This team will implement the draft protocol, evaluate the change detection capability of the method, revise the protocol as necessary, and produce a final protocol for approval by the network and by national I&M program coordinators. The team will require the use of a GIS-capable computer, and a shared (half-time) park vehicle for 1/2 of one calendar year. *Interim products:* a final approved protocol ready to begin full implementation of cyclic wetlands monitoring.

Literature Cited

Cowardin, L.M. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. DOI, Fish and Wildlife Service, Office of Biological Sciences, Washington D.C.

Appendix 4: Protocol Development Summaries

Protocol Development Summary

Riparian Habitat

Parks where protocol will be implemented: GOGA, JOMU, MUWO, PINN, PORE, PRES

Justification/Issues being addressed:
Riparian Habitat was ranked 16th among all of the potential vital signs evaluated by the SFAN. Riparian habitat is closely tied to the health of both wetlands and streams, two indicators that the network has proposed for monitoring. Riparian habitat also influences stream fish assemblages. Characteristics of riparian habitat structure such as the ratio of edge to interior, the degree of canopy complexity within riparian strata (e.g., herb/forbs, shrubs, subcanopy tree, and overstory tree), and the degree of fragmentation is highly associated with amount and type wildlife use.

Monitoring questions to be addressed by the protocol:

1. Is vegetation community structure functioning within a natural range of variability (i.e. habitat for wildlife species, stabilization for the stream bank, and nutrient cycling)?
2. Is riparian habitat size or distribution changing?

Specific draft monitoring objectives are:

- Determine status and trend of riparian habitat by measuring species composition, habitat structure, and width along streams in SFAN parks.

Basic Approach:
Portions of this indicator would be covered through the monitoring of wetlands, plant communities, and landscape change. Issues not specifically addressed by these indicators would be developed for more specific riparian monitoring.

Aerial photograph interpretation:

- Width of Riparian Zone: width in meters of riparian habitat along either side of creek. Relates to functions such as dissipation of stormwater flows, nutrient retention/water quality improvement, and ratio of edge to interior habitat for wildlife species.
- Width of Corridor Available for Lateral Migration: channel migration through avulsive or accretive meandering is highly associated with riparian establishment and senescence processes. Corridor width is determined not only by geologic/topographic constraints (e.g., narrow gorge or canyon), but anthropogenic-related structures such as levees, construction of flood control channels, residential, commercial, and agricultural development adjacent to creeks, etc.

- Length of Unfragmented Riparian Corridor: length of unfragmented riparian habitat along either side of creek in meters. Averaged for both sides of creek and expressed as average per kilometers of creek. Unfragmented habitat provides more of the functions associated with riparian habitat, including better transportation corridor for wildlife.

Channel Typing: Use of Rosgen/CDFG Methodology:

- Degree of Entrenchment: The degree of channel incision. The ability of a creek to support a diverse, broad expanse of riparian habitat is related to the degree of entrenchment. The more entrenched the creek, the less potential for riparian establishment and successional processes.
- Degree of Disturbance/Functionality: Assessment for signs of disturbance such as excessive erosion, signs of rip-rap, stresses from cattle use, etc.

Vegetation Field Surveys:

- Total Percent Vegetation Cover in herb/forb, shrub, subcanopy tree, and overstory tree strata. Percent cover in the various strata as determined through releve or point-intercept methods. A diverse mixture of cover in various strata increases attractiveness of riparian habitat to wildlife species.
- Community Composition, including percentage of non-native species: Composition of species within riparian habitat, including percentage of non-native species.

Frequency:

Every 5 years

Timing:

Vegetation surveys should be timed to coincide with maximum canopy cover, probably in August-September.

Principal Investigators and NPS Lead:

Brannon Ketcham, PORE Hydrologist (415-464-5192) and Marie Denn, NPS Pacific West Region Aquatic Ecologist (415-464-5222).

Proposed Development Schedule, Budget, and Expected Interim Products:

YEAR	BUDGET	TASKS/PRODUCTS
D1		Compile potential monitoring methods to address draft monitoring questions. Determine which metrics are currently being captured via other monitoring programs (plant community change, Stream fish assemblages). Field test sampling methods at SFAN parks.
D2		Write draft protocols. Implement pilot program to test monitoring protocols and data analysis. Develop database.

D3/I		Peer review monitoring protocols. Implement monitoring program.

D = Development I = Implementation

Not receiving I & M funds in FY05-FY07 draft budget. The vegetation metrics will be partially covered through plant community change monitoring protocols. Some of the habitat metrics may be covered through stream fish monitoring.

Appendix 4: Protocol Development Summaries

Protocol Development Summary

Landbird Population Dynamics

Parks where protocol will be implemented: GOGA, JOMU, PINN, PORE, and PRES

Justification/Issues being addressed:
Landbirds were ranked 17th among all of the potential vital signs evaluated by the SFAN. Landbird monitoring is focused in riparian and coastal scrub/chaparral habitats which were ranked as a high priority for SFAN parks. Landbirds are good indicators of terrestrial ecosystems because numerous dynamic processes interacting together have the potential to affect their abundance and distribution. Changes in species abundance, distribution, and reproductive success are critical parameters that may be caused by changes in habitat, food supply, park management strategies, disturbance to nesting areas by recreational users, or environmental factors on multiple scales (localized storm events to decadal shifts in climate). Monitoring annual adult survival is also important for understanding population trends in order to better understand the various influences on demographic patterns.

Specific monitoring questions and objectives to be addressed by the protocol:

1. What are the long-term trends in species composition and abundance of the landbird guild?
2. What is the natural level of variation in population distribution and abundance of the landbird guild?
3. What is the productivity of selected landbird species in the parks relative to other reference areas?
4. How do management activities that affect plant communities affect the composition and abundance of landbirds?
5. How are long-term climate changes affecting reproductive success, survival, and phenology of migration and reproduction.

The monitoring objectives are:

- Determine the annual changes in species composition, distribution, and abundance for landbirds in priority habitats including riparian and coastal scrub / chaparral habitats.

- Determine long-term changes in reproductive success of landbirds in priority habitats including riparian and coastal scrub / chaparral habitats.

- Determine long-term changes in annual survival for landbirds in priority habitats including riparian and coastal scrub / chaparral habitats.

Basic Approach:
The NPS Inventory and Monitoring Program has developed guidance for monitoring landbirds in national parks (Fancy and Sauer 2002). These guidelines will be used to evaluate and modify historic and on-going monitoring efforts in order to develop the SFAN Landbird Monitoring Protocol..

Sampling will involve point count surveys (variable point count distance sampling), mist-netting and banding (MAPS protocol), and periodic vegetation sampling. Sampling will be primarily on a Network-level spatial scale (within and among parks) in order to inform park managers of park-specific changes. Monitoring will be focused in two habitat types, riparian and coastal scrub/chaparral, which are priority habitats for the Network and parks involved in this monitoring. Even though local changes may occur due to changes in habitat quality or quantity. effective and efficient management actions must have knowledge of larger-scale patterns. We believe our sampling will provide adequate precision at the local and regional network scales, in addition to benefiting from being part of, and informed by, larger-scale monitoring efforts (e.g., MAPS, BBIRD, Breeding Bird Survey, Christmas Bird Count). We plan to continue current levels of monitoring with the addition of establishing replicate plots in PORE, GOGA, PINN, and JOMU These plots can include the survey areas established during the inventory phase.

PORE and GOGA: (1) Continue mist-netting at all previously established / currently monitored mist-netting study sites year-round at Palomarin, Muddy Hollow, and Pine Gulch and only during the breeding season at Lagunitas Creek and Redwood Creek. (2) Continue nest monitoring at Palomarin (3) Conduct point count surveys annually at all previously established / currently monitored stations in coastal scrub / chaparral and riparian habitats. (4) Establish mist netting at one new coastal scrub site (likely the same as one of the proposed point count plots). (5) Establish point count surveys at two new coastal scrub sites (likely one site will be the same as the proposed mist-netting station). (6) Conduct vegetation sampling at all point count survey sites once every five years.

PINN and JOMU: (1) Conduct point count surveys annually at all previously established stations. (2) Conduct vegetation sampling at all point count survey sites once every five years.

Principal Investigators and NPS Lead:
Protocol development was partially completed through a cooperative agreement with the PRBO Conservation Science. Principal Investigators will be Thomas Gardali, Grant Ballard, and Geoffrey R. Geupel from PRBO (415-868-0655), William Merkle, GOGA Wildlife Biologist (415-331-2894), and Dr. Sarah Allen, PORE Senior Scientist (415-464-5187). NPS Lead: William Merkle.

Proposed Development schedule, budget, and expected interim products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05 I	$42,000 (PRBO contract)	Peer review and revise protocols. Implement monitoring in SFAN parks. Complete summary report.

FY06 I	$44,000 (PRBO contract)	Implement protocols. Complete summary report.
FY07 I	$47,000 (PRBO contract)	Implement protocols. Complete summary report.

D = Development
I = Implementation

Literature Cited

DeSante, D.F. et.al. 2001. MAPS Manual: 2001 Protocol. The Institute for Bird Populations, Point Reyes Station, CA.

Fancy, S.G. and J.R. Sauer. 2002. Recommendations for Inventorying and Monitoring Landbirds in National Parks. DOI, National Park Service Inventory and Monitoring Program.

Nur, N., S.L. Jones and G.R. Geupel. 1999. Statistical Guide to Data Analysis of Avian Monitoring Programs. DOI, Fish and Wildlife Service, Biological Tech.Rept. BTP-R6001-1999, Washington D.C.

Ralph, C.J. et.al. 1993. Handbook of Field Methods for Monitoring Landbird Populations. USDA, Forest Service, Pacific SW Reseach Sta., Gen.Tech.Rept. PSW-GTR-144.

Appendix 4: Protocol Development Summaries

Protocol Development Summary

Raptors and Condors

Parks where protocol will be implemented: PINN

Justification/Issues being addressed:
Raptors and Condors were ranked 18th among all of the potential vital signs evaluated by the SFAN. Long-term trends in the nesting success and productivity of prairie falcons provide a means for assessing the park's ability to adequately manage climbing use and the overall ecological integrity and sustainability of the rock/cliff ecosystem. Long-term patterns in population size and breeding behavior (e.g. feeding rates of chicks) are compared to long-term climate change, effects of conversion and development of agricultural lands surrounding the monument, and visitor use of the monument. This information will improve the understanding raptor ecology and the effects of park management decisions. PINN has a long history of monitoring prairie falcons. Condors were recently re-introduced to PINN and will be included in the I & M program in the future.

Monitoring questions to be addressed by the protocol:

1. Are annual reproductive rates of raptors at PINN changing over time?
2. What are the major threats to nesting raptors?
3. How can threats be minimized or mitigated?

Specific monitoring objectives are:

- Determine annual nesting success at Pinnacles NM as measured by territories occupied, number of chick produced and number of chicks fledged.

- Monitor potential threats (i.e. presence of hikers or climbers), and estimate degree at nesting sites in order to identify management needs.

Basic Approach:
Nest survey monitoring using protocols defined in Fesnock (park staff) and Rechtin 2002. Monitoring of migratory raptors at GOGA uses protocols developed by the Golden Gate Raptor Observatory.

Frequency:
Every year
Timing:
January through fledging (June-August), 1-3 week intervals at each nest.
Migration Aug-Dec

Principal Investigators and NPS Lead:
Jim Petterson, PINN Wildlife Biologist (831-389-4425, x223)

Proposed Development Schedule, Budget, and Expected Interim Products:

YEAR	BUDGET	TASKS/PRODUCTS
FY05 D/I	$21,000	Revise protocol based on peer review. Implement monitoring of prairie falcons at PINN. Complete annual report.
FY06 I	$0 (seeking other funds)	Implement monitoring of prairie falcons at PINN. Complete annual report.
FY07 I	$24,000	Implement monitoring of prairie falcons at PINN. Complete annual report.

D = Development
I = Implementation

Literature Cited

Emmons, G. 2003. Raptor Breeding Season. Unpubl. Rept. DOI, National Park Service, Pinnacles National Monument, Paicines, CA.

Rechtin, J. A. 2002. 1994-2002 Raptor Nesting at Pinnacles National Monument. Unpubl. Rept. DOI, National Park Service, Pinnacles National Monument, Paicines, CA.